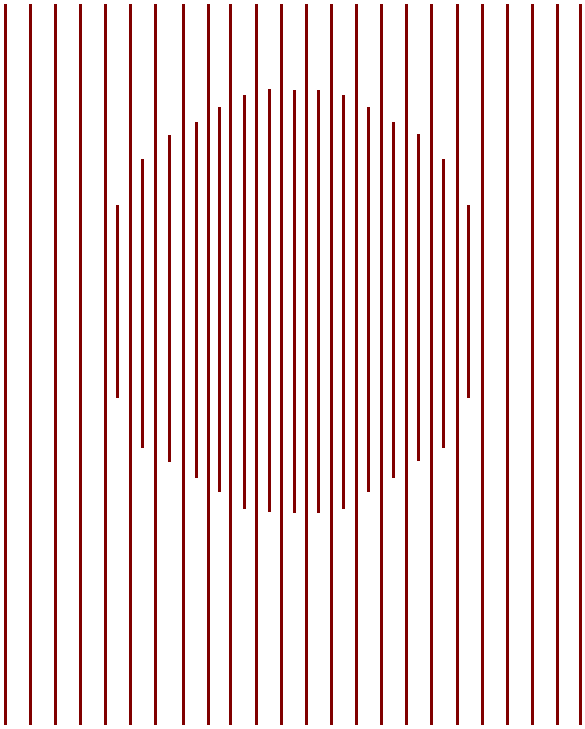
CBO PAPERS

RECENT DEVELOPMENTS IN THE THEORY OF LONG-RUN GROWTH: A CRITICAL EVALUATION

October 1994



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PREFACE

Recent developments in the theory of long-run growth suggest that certain federal policies--including deficit reduction--will have much larger effects on economic growth than conventional theory would predict. This Congressional Budget Office (CBO) paper provides a critical survey of the old and new frameworks, with particular emphasis on empirical evaluation of them.

Robert Arnold of CBO's Macroeconomic Analysis Division prepared the paper under the supervision of Robert Dennis and John Peterson. Bruce Arnold, Doug Elmendorf, John Hakken, Doug Hamilton, Kim Kowalewski, Tom Loo, and Ralph Smith made valuable comments on an earlier draft. The paper also benefited from useful suggestions by Martin Neil Baily of the McKinsey Global Institute. Laurie Brown and John Romley helped produce the figures.

Sherry Snyder edited the paper, with the assistance of Chris Spoor, and L. Rae Roy and Dorothy Kornegay prepared it for publication.

Robert D. Reischauer
Director

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SUMMARY

New theories of economic growth developed by Paul Romer and others have led economists to question whether the neoclassical (that is, Solow) model is the most appropriate model of long-run economic growth. The new theories, collectively known as endogenous growth models, try to explain the fundamental forces that drive long-run growth rather than rely on factors determined outside the theory, as the neoclassical theory does. These theories are of interest to policymakers because they imply that government policies, including deficit reduction, can have much larger effects on growth in the long run than Solow's model would predict.

This paper provides a critical survey of the literature on the neoclassical and endogenous growth models, with particular emphasis on the recent explosion of empirical work. It concludes that the evidence does not justify discarding the neoclassical model. With suitable modifications, the neoclassical model can explain some of the anomalies for which it has been criticized, and with these modifications, it fits the historical data better than the new models. In addition, the two frameworks are not really substitutes--the best of the new theories can be interpreted as extensions of the neoclassical model.

THE NEOCLASSICAL MODEL

For over three decades, the neoclassical model has been the primary theoretical framework for virtually every study of long-run economic growth. Developed by Robert Solow, the model features a neoclassical production function that explains the level of output in terms of two factor inputs--labor and capital. Using a few simplifying assumptions about the growth of the inputs, the model predicts the existence of a stable growth path for output. However, in equilibrium, the growth of output is limited to the growth of the labor force, meaning that per capita output (a crude measure of the standard of living) is constant through time. This prediction is at odds with the historical record, which shows sustained increases in per capita output over very long periods. To explain the growth of per capita output, Solow introduced the idea of technological change.

The model's assumptions about decreasing returns ensure that per capita output does not grow without technological progress. Intuitively, this assumption means that successive increases in the amount of, say, capital used

in production (holding the number of workers constant) will yield progressively smaller increases in output. If returns to additional investments do not fall, it will always be profitable to invest, capital will continue to accumulate perpetually, and per capita output can rise indefinitely.

Another important prediction of the neoclassical model is known as convergence--a process by which economies with low starting values of per capita output (poor countries) grow faster than those with higher initial values (rich countries). The model predicts that the level of per capita output in all countries will converge to a common level. Convergence occurs in the neoclassical model because of decreasing returns to capital. Investment should be more profitable in poor countries than in rich ones because poor countries have lower levels of capital per worker and, therefore, a higher return to capital. This means that poor countries not only will get a bigger "bang per buck" of investment spending but also will attract a disproportionate share of foreign investment. One problem with the prediction of convergence is that it requires that countries be identical in every respect except their level of per capita output.

Proponents of endogenous growth cite three limitations of the neoclassical model as the motivation for developing their models. First, it relies on technological change to supply growth in per capita output. Instead of explaining the sources of technological change, the model assumes it will occur independent of factors considered by the model. Second, the neoclassical model provides only a rudimentary framework for analyzing the effects of government policy on long-term growth. Although it is not obvious that government actions can raise economic growth, policy changes clearly affect the day-to-day decisions made by consumers, managers, and investors. It would be desirable to have a framework to analyze the effects of such changes on long-term growth. Third, the model has limited tools for analyzing international trade and its link with economic growth. In particular, empirical evidence suggests that countries with an outward orientation seem to grow faster than those that are more protectionist. The neoclassical model, however, cannot address the question of whether openness to trade causes faster growth.

THEORIES OF ENDOGENOUS GROWTH

Economists have recently developed theories that address the shortcomings of the neoclassical model. The defining characteristic of the new models is that they generate growth of per capita output endogenously--that is, without assuming that technological change occurs outside of the model's framework.

Hence, they are known as endogenous growth models. Although the models share the same basic idea, they rely on different mechanisms to drive long-run growth. Some models explain the forces that lead to technological change, and others modify the structure of the model so that investment in physical or human capital sustains growth.

The recent literature on endogenous growth was initiated by Paul Romer, who examined the idea that spillovers could be associated with the accumulation of knowledge. (A spillover is an action taken by one person or firm that affects another person or firm.) Romer showed that spillovers could be strong enough to outweigh the drag caused by decreasing returns to capital and sustain growth in per capita output. Later, Romer refined his model to explain why companies invest in research and development (R&D) when they know that any ideas that result will eventually benefit their competitors. He found that as long as society does not reach some type of technological limit, continuous innovation can allow per capita output to grow forever.

One important advantage of Romer's model is that it does not supplant the neoclassical model. Instead, it fills an important gap in the neoclassical theory by providing a rigorous description of the source of technological progress. Romer points out that if innovation in his model was to stop, then his model would collapse to the neoclassical model.

Following Romer, other economists have developed models that expand the idea of endogenous growth. Although they use different variables and functions, all of the endogenous growth models have the same fundamental characteristic: they reverse the effects of decreasing returns to capital. Several models focus on the importance of accumulating human capital--gaining increased skills through formal education or on-the-job training. Others focus on international trade--in particular, on how the international pattern of comparative advantage influences trade and growth. Still others examine the idea of convergence and whether it is consistent with endogenous growth, or analyze the link between fiscal policy and endogenous growth.

These models of endogenous growth are very abstract, so they do not yield specific policy prescriptions. However, they point to certain types of policies that are more likely than others to influence long-run growth. Those policies include lowering barriers to trade, reducing taxes on capital income, and focusing government spending on services that improve productivity in the private sector. One area that looks particularly promising is human capital and training. Many endogenous growth models point to innovation as the key driver of long-run growth, and to a highly educated labor force as the key input to R&D. Although the models are as yet too crude to support the

argument that the government should subsidize training or education, they demonstrate that the government should avoid discouraging investments in human capital.

EMPIRICAL EVALUATION

It is difficult to evaluate two theoretical frameworks that have different explanations about the sources of economic growth when the only sample of data spans a period of sustained growth in per capita output. Heightening the problem of evaluation is the fact that the difference between the two frameworks is more quantitative than qualitative. The assumptions of the neoclassical model ensure that decreasing returns to capital set in rapidly; endogenous growth models assume that decreasing returns do not set in at all. The more slowly decreasing returns set in, the closer the results will be to those in the literature on endogenous growth.

Although definitive conclusions based on the empirical work in this area would be premature, some findings are well supported. Most important, the neoclassical framework is still appropriate for analyzing long-run growth. The latest work suggests that the model may need to be augmented to include human capital or to explain the sources of technological progress but that the basic structure should remain intact.

Most of the recent empirical work evaluating the neoclassical model has centered on the model's prediction of convergence. Much of the early evidence on this question showed that economies did not converge to common levels of per capita output. However, once researchers took account of differences in certain characteristics among countries, they found that economies have converged. What misled earlier researchers was that different countries were converging to different equilibrium levels of per capita output because they had different rates of saving, population growth, and so forth.

The empirical work examining convergence unearthed an anomaly associated with the neoclassical model. Although economies converge as predicted by the model, several papers showed that the rate at which they do so is much slower than the model would predict. One way to reconcile the predictions of the neoclassical model with the empirical evidence is to augment the model to include human capital along with physical capital. Including human capital weakens the effects of decreasing returns in the neoclassical model and slows the predicted rate of convergence to one that is consistent with the data.

Some models of endogenous growth differ from the neoclassical model because they assume that decreasing returns to capital do not exist. A natural test of these models is to measure the extent of decreasing returns, if any. Estimates of the return to capital are elusive, and some of the evidence is contradictory, but the consensus is that decreasing returns to capital do exist.

Models of endogenous growth that rely on the spillover of knowledge (as described by Romer) to drive long-run growth can be evaluated by searching for evidence of such spillovers. And, in fact, there is good evidence to suggest that they do exist. Unfortunately, most empirical analysis relies on firm- or industry-level data and, therefore, does not demonstrate the importance of spillovers for growth of per capita output at the economy wide level. The evidence is, however, extremely suggestive; it is likely that innovation and knowledge spillovers will be key elements of any complete theory of long-run growth.

What conclusions can be drawn from this study? Most important, the neoclassical framework is still the most appropriate model of long-run growth. Its crucial assumptions--in particular, decreasing returns to capital--appear to be justified, and careful empirical studies support many of its predictions. Some recent empirical studies suggest that the model should be augmented to include human capital; doing so raises the model's prediction of the benefits of deficit reduction. The major shortcoming of the model is its assumption of exogenous technological progress.

Recent studies of endogenous growth have provided many new ways to think about long-run growth and a more diverse set of mechanisms for analyzing the effects of government policy. The highly abstract early models have given way to more realistic models that have better empirical support. In fact, it is difficult to make a clear distinction between the neoclassical and endogenous growth frameworks because the differences between the two are steadily shrinking. Many of the latest models are better viewed as extensions of the neoclassical model rather than replacements for it. The models that include an explicit treatment of the economics of innovation provide an important step toward a complete description of the process of technological change.